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The Ancient Volcanic Rocks of South Mountain, Pennsylvania.

By FLORENCE BASCOM. Bulletin U. S. Geological Survey, 136, Washington, 1896.

When the work on the porphyries of South Mountain was taken up, little was definitely known regarding the occurrence of ancient volcanic rocks in the eastern United States outside of the region in Massachusetts in which certain felsites had been found. Having come across a specimen of the porphyry from South Mountain, Professor G. H. Williams and Miss Bascom visited the region to learn more with regard to its occurrence, and finding unmistakable evidence of the presence of an ancient igneous rock with pronounced flow structure and indications of spherulitic crystallization, it was decided to make a special investigation of the region. This was carried on in the summer of 1892, Professor Williams studying the northern part of the region and Miss Bascom the southern part. The latter also undertook a detailed study of the igneous rocks there found. Preliminary notices of the general geology of these volcanic rocks have been published by Professor Williams, and of the petrography of the most siliceous varieties by Miss Bascom. The present publication presents the complete investigation of all the igneous rocks of the region.

It reviews the literature bearing upon the district from 1755 to 1896. From this it is clear that the true character of the more siliceous rocks was not understood by previous investigators. Three types of rock occur, one a sandstone, conglomerate and quartzite, with occasional argillaceous shale; another an acid volcanic rock, and the third a basic volcanic rock. The sandstone is referred to the Lower Cambrian Age, though not definitely; and the igneous rocks are found to be older than the sandstone, being extrusive lavas overlaid unconformably by the sandstone. They are considered to be of pre-Cambrian Age, and their petrographical resemblance to the Keweenaw volcanic rocks of the Lake Superior region is pointed out. The acid rocks are probably older than the basic ones. But this could not be definitely determined.

Before entering upon the petrographical description of the acid eruptive rocks the author finds it necessary to devote four pages to a discussion of the nomenclature of the aphanitic, porphyritic and non-porphyritic varieties of these rocks—an excellent commentary on the present condition of petrographic terminology. At its conclusion the

author proposes to designate "all acid volcanic rocks the structures of which proves them to have once been glassy, *aporhyolites*, while such as were originally holocrystalline, or whose original character is in doubt, will be termed quartz-porphyrines." The prefix *apo* is intended to indicate the fact of a special kind of alteration, namely, that of devitrification of a solid glass. Its application is therefore limited to a certain class of rhyolites, that is, the hyalorhyolites.

The varieties called quartz-porphyry are briefly described, and call for no special comment, except to note the occurrence in them of the unusual mineral piedmontite together with ordinary epidote, both being secondary minerals. The aporhyolites are described at length. They are characterized by numerous spherulites and some lithophysæ, most clearly reorganized on weathered surfaces of the rock. Their form and distribution are the same as in recent, unaltered obsidians. The description of the phenocrysts of feldspar is not entirely satisfactory and their actual character is left in doubt, except that they are undoubtedly alkaline varieties.

The microscopical study of the groundmass has been very thoroughly carried on, and the descriptions make it evident that there once existed in these rocks textures commonly found in modern rhyolites, such as flow-structure, taxitic structure, perlitic cracking and spherulitic crystallization, making it highly probable that these rocks originally solidified in a partially glassy condition. They are at present holocrystalline and exhibit a microcrystalline and also a micro-poikilitic texture. The latter is discussed at great length and its secondary character in these rocks is clearly established. The author recognizes the fact that the same or a similar texture is also a primary crystallization in certain other rocks. Flow-breccias and tuft-breccias are found in connection with the massive lavas. In places the massive rock is metamorphosed into a sericite-schist, in which often the original phenocrysts are still preserved. The chemical compositions of the two rocks are nearly identical.

The petrographical description of the basic eruptives begins with a discussion of the nomenclature relative to these rocks, which is short and leaves the subject in a confused condition; the confusion being carried throughout the chapter. The confusion is based on the conclusions arrived at in the paper by Professor W. S. Bayley, which is quoted by the author. The mistake is made in assuming that the definition of the groups within the gabbro class of rocks as suggested

by Professor Bayley is final, or even that it is acceptable to the majority of petrologists. So far as a distinction between gabbro and diabase is made to rest on purely textural grounds, one being granular and the other ophitic, Professor Bayley's conclusions are good, but the effort to relate these textures to the mode of occurrence of the rock, as intrusive or extrusive, is futile, and the suggestion that the term diabase be applied to holocrystalline extrusive lavas having the composition of gabbro, and the term basalt to those that are hypocrySTALLINE (partly glassy) is wholly impracticable. Throughout the chapter the terms melaphyre, augite-porphyrite and diabase are used as synonyms. It does not appear from the description in what sense the term augite-porphyrite is to be understood, since the structure and mineral constituents of these basic rocks at South Mountain are said to be markedly uniform (*op. cit.* p. 72.); the texture is micro-ophitic and the porphyritic structure is inconspicuous, the largest feldspars being 0.8^{mm} long. Since it is not possible to prove that the original lavas were or were not glassy, they are classed as having been originally crystalline and for this reason are called diabase in the sense suggested by Professor Bayley. The term apo-basalt could not have been used without question.

Although the rocks have been greatly altered, enough of their original texture has been preserved to render their identification satisfactory. They had the mineral composition and texture found in many recent basalts. In some cases olivine still remains, in others its outline only is left. In some cases lime-soda-feldspar, augite and magnetite still exist. The secondary minerals formed are quartz, epidote, actinolite, chlorite, and leuxocene. Their relative proportions vary in different places. With very complete change in mineral composition there is surprisingly little change in the texture of the rocks. The chemical analyses of the altered rock shows considerable divergence in some constituents from the composition of normal basalts. Amygdaloidal, brecciated and tuffaceous forms of the rock occur, which clearly indicate the extrusive character of the lavas. The amygdaloidal varieties have been specially liable to metamorphism, resulting in schists, or slates, spotted where the former amygdales have been dragged into flattened disks.

The bulletin closes with a summary of the facts and conclusions regarding the occurrence and nature of the rocks, and with a brief notice of the occurrences of similar ancient volcanic rocks in North

America, and also with a valuable list of papers in which points of resemblance between ancient and modern acid volcanic rocks have been emphasized, and those treating of devitrification and of spherulites. The paper is well illustrated by twenty-eight plates and is a valuable contribution to our knowledge of ancient and more or less metamorphosed volcanic rocks.

The restriction of the prefix apo to those altered rocks that originally contained glass, leaves unsatisfied the demand for a general term which can be applied to all more or less metamorphosed lavas that once corresponded to unaltered rhyolites, basalts, andesites, etc., whether glassy or holocrystalline. In this case it would seem advisable to adopt the prefix eo, proposed by Nordenskjöld¹ without regard to any particular age, indicating simply that the altered rock had originally been what the remainder of the term signifies. In this sense the volcanic rocks of South Mountain might be called eorhyolites and eobasalts.

J. P. IDDINGS.

¹ *Ueber archaische Ergussgesteine aus Småland*. Bull. Geol. Instit., Upsala, No. 2., Vol I., 1893.